

Space Weather Technical Forecast

Issued on Saturday, 21 January 2023 at 13:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: R1/R2 Radio Blackouts considered likely throughout. Chance of G1/Minor Geomagnetic Storms days 3 and 4 (23rd and 24th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low through the past 24 hours, with C-class flares, the largest was a C7.3 event observed at 20/2247 UTC. A CME from 20th has been analysed as missing ahead, though there is a chance of glancing impacts at Earth on day 3 (23 Jan). No other Earth-directed CME have been observed.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as measured at ACE, have been on a slow gradual upward trend, rising from around 400 km/s ending around 500-550 km/s by the end of the period. Density rose from below average to average by 21/0400 UTC before falling back below average later on 21st. The IMF was generally steady at moderate levels initially, before becoming erratic and fluctuating between weak and moderate levels during 21st, with a peak of 10 nT. The north-south component (Bz) was weak and mostly positive initially before becoming erratic with a more prolonged spell of negative Bz at mostly moderate levels between 21/0300-0600 UTC. The phi angle was predominately positive (away from the Sun) initially but became erratic during 21st. Geomagnetic activity was Quiet to Unsettled (Kp 0-3), with two Active (Kp 4) intervals between 21/0300-0900 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has been at Background levels throughout, with two minor proton responses to unknown events.

High energy electron flux (greater than 2 MeV) has been at background levels. The 24-hour integrated electron fluence stayed below the Active threshold on a downward trend, with 2.36e6 integrated pfu observed at 21/0001 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low or Moderate, with a slight chance of reaching High levels over the next four days. There are numerous regions on the disc, but the most obvious candidates for a significant flare remain AR3190 and AR3192.

Solar Wind / Geomagnetic Activity: The HSS from CH68/+ will likely continue to effect Earth during day 1 (21st) perhaps into day 2 (22nd), though easing over time. 2 CME's may effect Earth during day 3 (23rd), though both are low confidence. CH69/+ is likely to connect with Earth during day 4 (24th), with speeds of around 550 km/s expected.

Generally Quiet to Active geomagnetic activity is expected through the period, with a slight chance of G1/Minor storms day 1 (21st) due to then HSS of CH68/+, then a chance of G1/Minor storms on days 3 and 4 (23rd and 24th) due to potential CME arrivals and then the HSS of CH69/+ respectively.

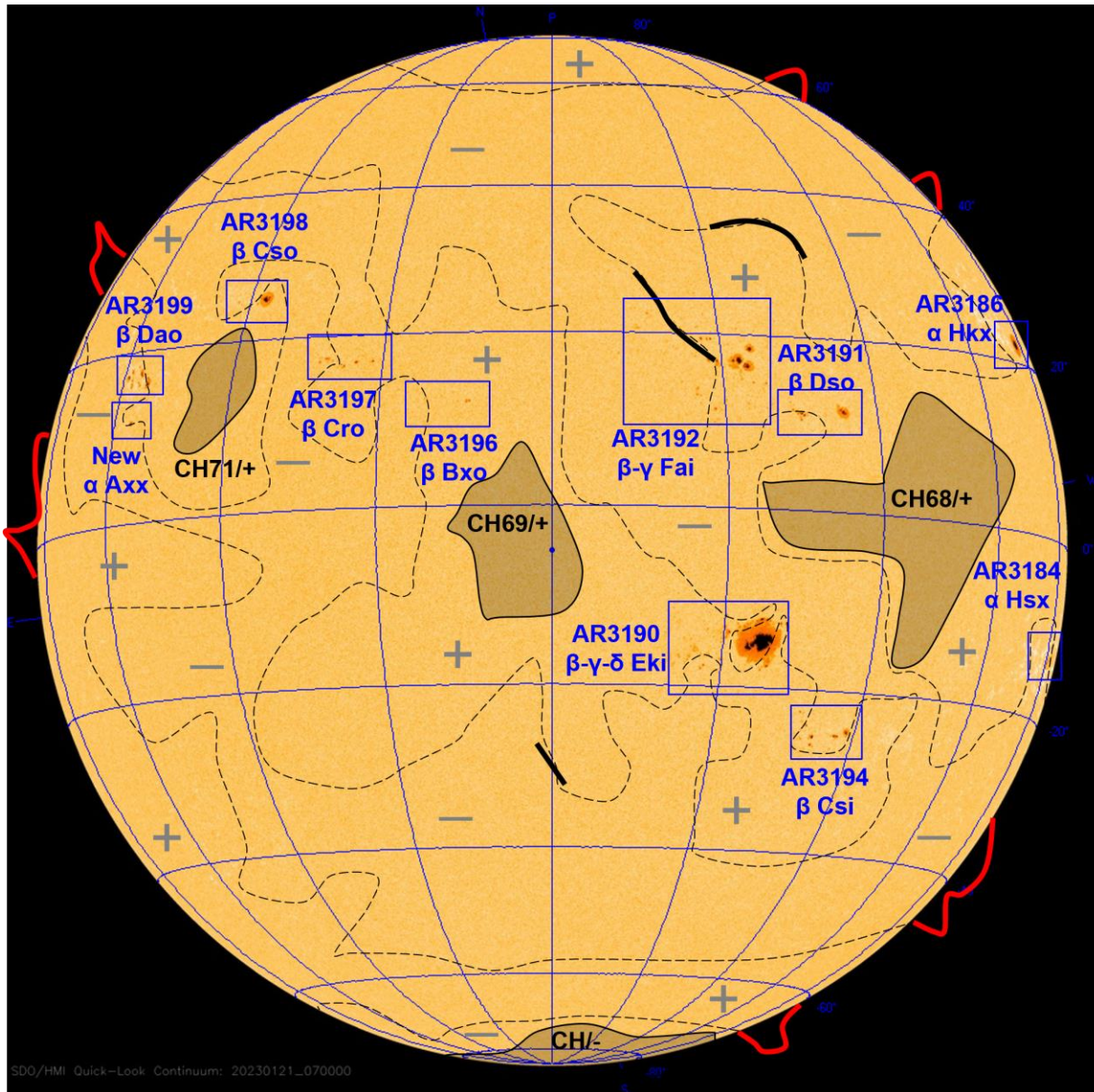
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at predominantly background levels, but with a slight

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chance of reaching S1 or greater through the period.

Electron flux should remain at background to moderate levels, although with a chance of rising to active during the diurnal peaks of days 2 and 3 (22nd and 23rd). Electron fluence is likely to stay below the Active threshold, but with a slight chance of Active electron fluence on days 2 and 3 (22nd or 23rd).

Figure 1. Solar Analysis Valid 21/0800 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There is now evidence of the HSS from CH68/+ arriving during the morning of 21st UTC. This will likely continue to effect Earth during 21st perhaps into 22nd, though easing over time.

2 CME's may effect Earth during 23rd, the first from a faint halo signature associated with a flare from the NE on 19th. The second from a filament eruption from the SW on 20th, this may give glancing impacts, though both are low confidence.

CH69/+ located on the solar meridian is likely to connect with Earth during 24th, although this feature did not appear on previous rotation, therefore persistence is considered poor guidance. Speeds of around 550 km/s could be expected with this feature.

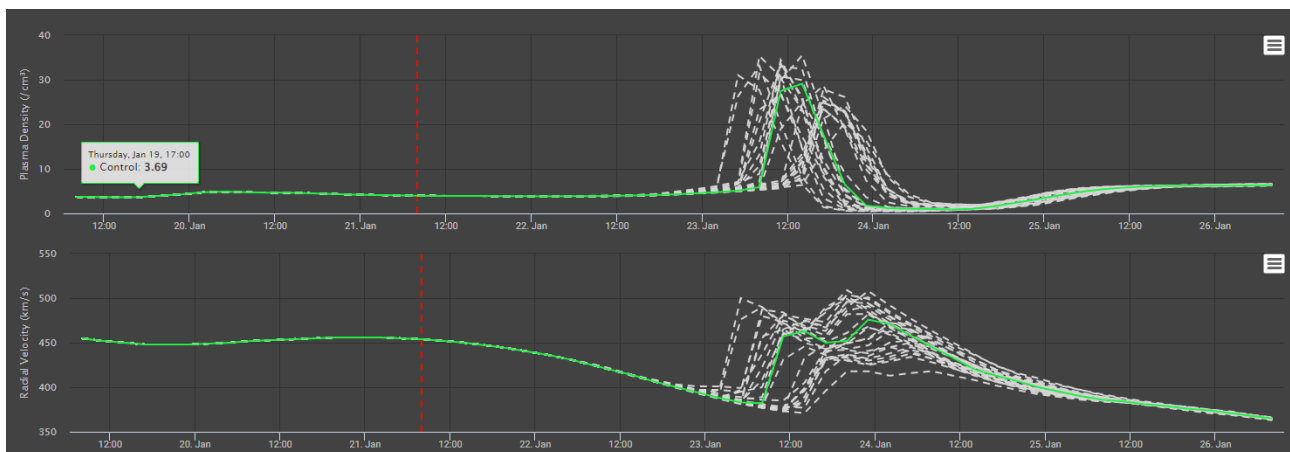
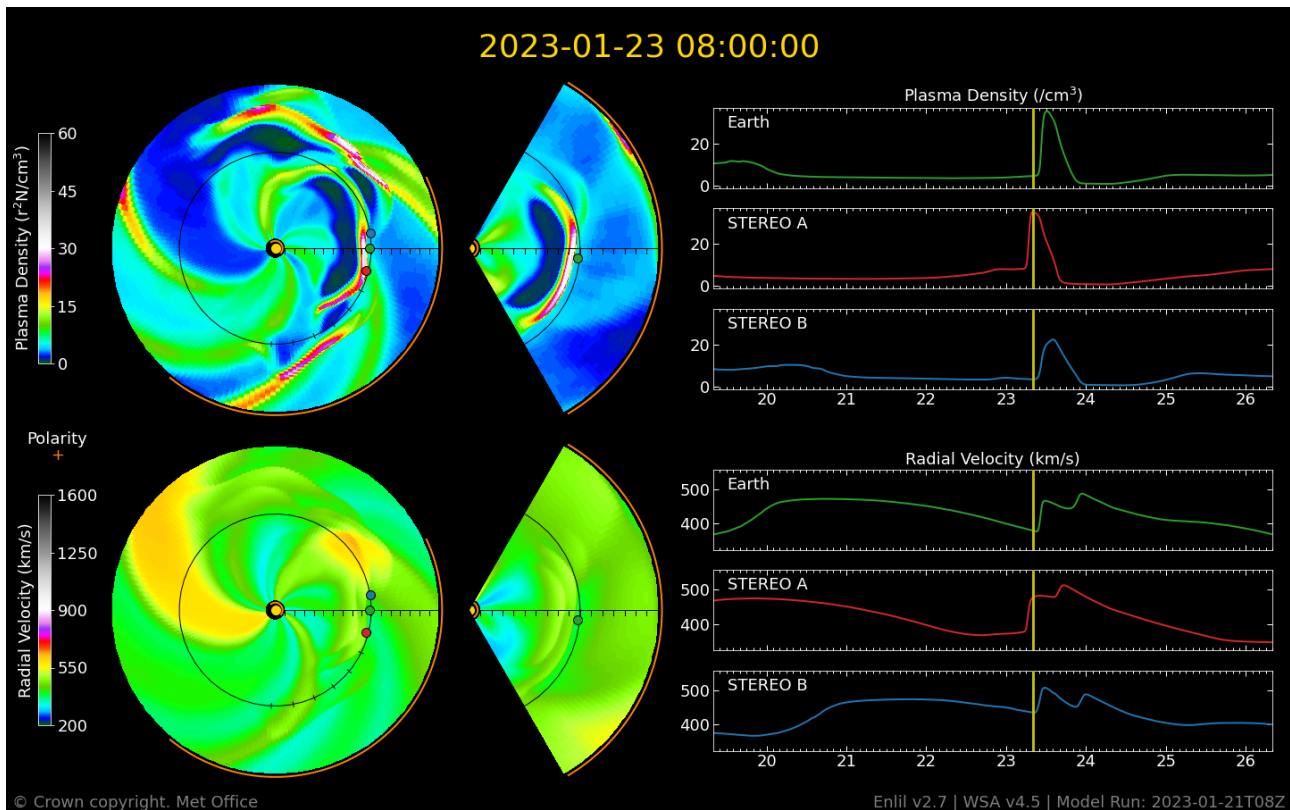
Generally Quiet to Active geomagnetic activity is expected through the period, with a slight chance of G1/Minor storms day 1 (21st) due to then HSS of CH68/+, then a chance of G1/Minor storms on days 3 and 4 (23rd and 24th) due to potential CME arrivals and then the HSS of CH69/+ respectively.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	5	30	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0940	Full	Filament Eruption	NE	500 km/s	23/0900	Very faint, low confidence.
20/1847	Partial	Filament eruption	SW	770 km/s	23/1200	Possible glancing blow, otherwise missing ahead.

Figure 2: MOSWOC ENLIL showing possible CME Arrivals.



Radio Blackouts - X-Ray Flares:

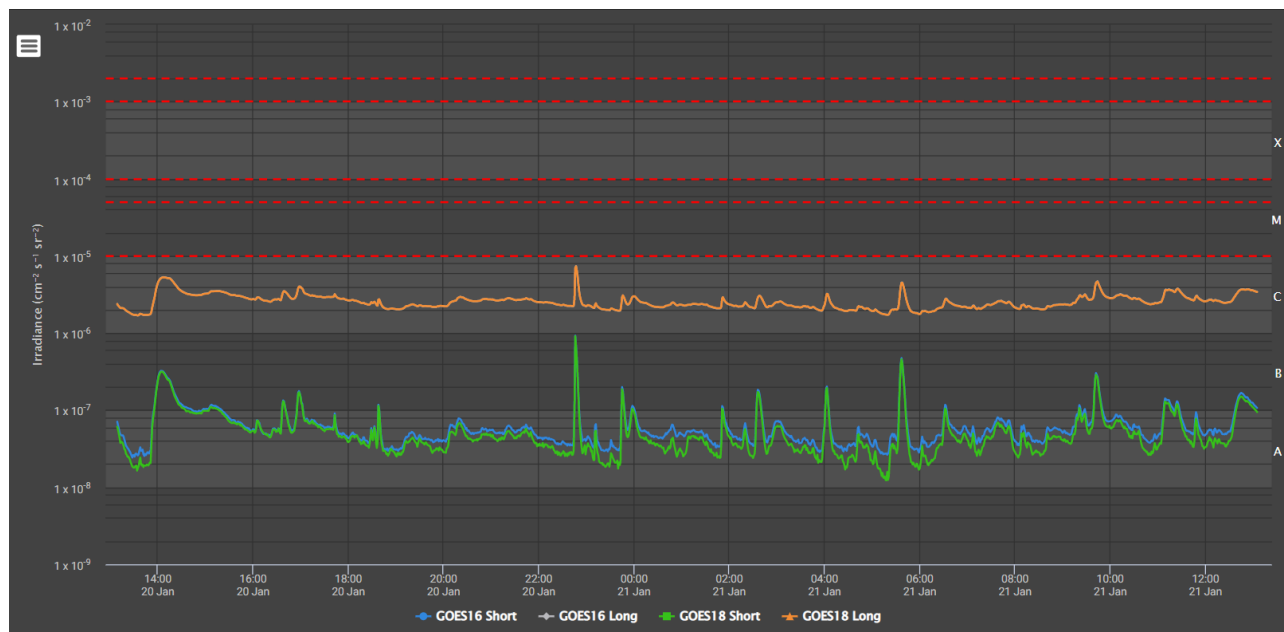
Solar activity has been Low through the past 24 hours, with several C-class flares observed. The largest was a C7.3 flare observed at 20/2246 UTC.

Solar activity is expected to be Low to Moderate, with a slight chance of reaching High levels throughout as the most complex regions continue to rotate west.

There are ten numbered and one un-numbered sunspot regions on the visible disc. AR3190 remains the largest and most complex, with some growth around its large leader spot, recently developing two delta spots here, one to the north and one to the south. AR3192 retains numerous spots and some magnetic complexity, but continues to show decay. Other regions are smaller and simpler, though the recent development of AR3199 will continue to be monitored.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: X-Ray trace past 24 hours





Solar Radiation Storms - (High Energy Protons):

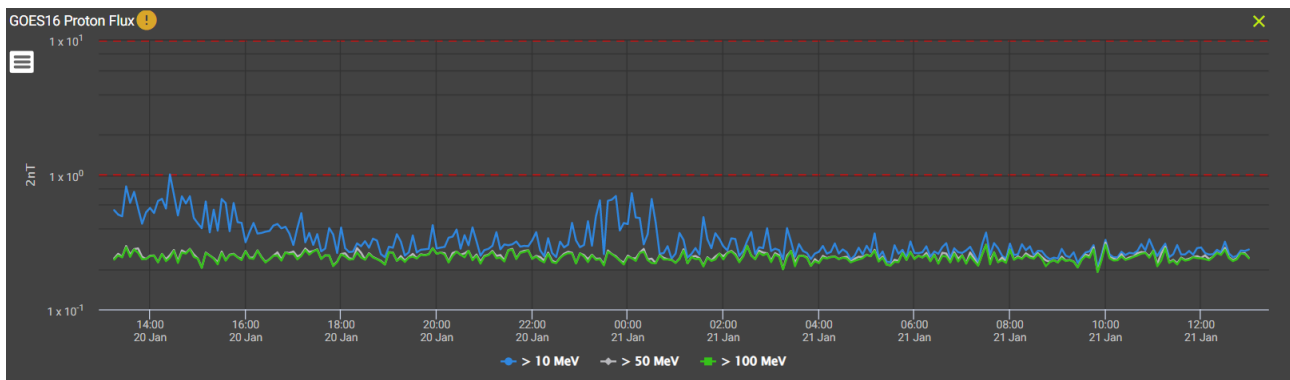
The high energy (greater than 10MeV) proton flux is currently at background levels.

While no recent S1+ events have been observed at GEO, the sheer number of both front and far-sided complex groups dictates an elevated risk. Both AR3190 and AR3192 bring an increased risk as they rotate westwards. As such, a slight chance of S1 or greater continues through this four day period.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	15	15	15	15
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: Proton Trace past 24 hours



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux remains at background to moderate levels. Electron flux should remain at background to moderate levels, although with a chance of rising to active during the diurnal peaks of days 2 and 3 (22nd and 23rd). Possible CMEs on 23rd may act to redistribute the electron fields, therefore reducing the risk into day 4 (24th).

Electron fluence is likely to stay below the Active threshold through the period, but with a slight chance of Active electron fluence on 22nd or 23rd in the wake of CH68/+ and before the possible arrival of 2 CME's on 23rd. The MOSWOC REFM model is considered as a good overall trend for the four day period, though individual data points are unlikely to be closely matched.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	5	20	20	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM showing observed, modelled and persistence Fluence.

